N-Rich Reference Zone Case Study: Siskiyou County 2020

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Two nitrogen (N) rich reference zones, measuring 42ft x 480ft each, were established on a 7.7 acre irrigated wheat field in Siskiyou County, where typical grain yield and protein levels are 8000 lb/ac and 11%, respectively. This field sits on fertile reclaimed lake-bottom soil with more than 5% organic matter content. The mean temperatures range from 73 (summer maximum) to 29°F (winter minimum), and the annual average precipitation is approximately 12 in.

N rich reference zone creation:

- Pre-plant soil samples of the top 0-12 in. of soil were taken on 4/6/20 and sent to the lab for analysis. The lab results showed an estimated fertilizer equivalent of 28 lb/ac N.
- While the field as a whole received no pre-plant N fertilization, the two N-rich reference zones received 140 lb/ac N as urea at planting. The N-rich reference zones were fertilized with a 10 ft pull behind drop spreader.
- The field was planted on 4/20/20 using a 12 ft Great Plains Drill with 6 in. row spacing. The seeding rate was 120 lb/ac.
- The previous crop was Sudangrass.

Early season conditions:

- The 2020 season had mild, cool weather in the early spring.
- Only 1.36 in. of rainfall fell from April to July, most in early May.
- The lack of moisture in the spring of 2020 permitted an earlier planting date than is normal for the site.
- The crop received 0.56 in. of rain and 3.8 in. of irrigation (18% of the season's total irrigation) between planting on 4/20/20 and the first in-season N assessments on 5/15/20.
- At the time of the in-season N assessment, the crop was at tillering stage of growth and approximately 5% of the seasonal N uptake total had occurred.

Plant and Soil Measurements:

- In-season measurements of the plant and soil N status (canopy normalized difference vegetation index – NDVI – and soil nitrate-N quick test on soil from 0-12 in.) were recorded on both 5/15/20 and 6/12/20. NDVI data was expressed as a Sufficiency Index (SI), or the ratio of the measurements from the broader field to the measurements from the N-rich reference zones. SI values less than 0.97 indicate possible crop N deficiency and values less than 0.93 indicate likely crop N deficiency.

SITE INFORMATION

Location: Siskiyou County
Soil type: Tulebasin mucky silty clay loam
Previous crop: Sudan Grass
Variety: WB 6341 (Soft-white spring wheat)
Seeding method: Grain drill
Seeding rate: 120 lb/ac
Planting date: 4/20/20
Bedded: No

Pre-plant N Management

Field rate: 0 lb N/ac
N rich zone: 140 lb N/ac
N Form: Urea

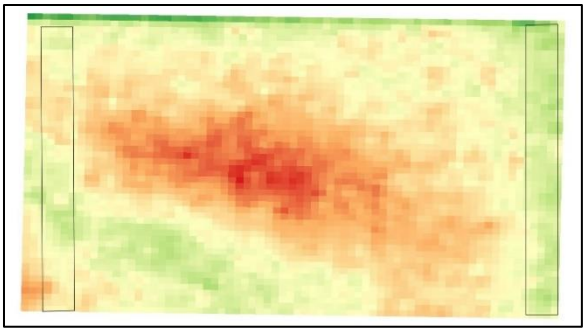

Figure 1. NDVI measurement recorded on 5/11/2020 (tillering stage of growth) by Planet Labs. Outlined areas indicate the locations of the N-rich reference zones.

- NDVI measurements taken on 5/15/20 resulted in an average SI of 0.86. The SI was consistent across the field and indicated that the field was very likely respond to N fertilization.
- The soil nitrate-N value in the top 0-12 in. of the soil indicated 7 lb/ac N fertilizer equivalent in the field and 36 lb/ac N fertilizer equivalent in the N-rich reference zones, which confirmed the relative N deficiency in the field.

Fertilizer recommendations and in-season management actions:

- Large increases in yield (+2500 lb/ac) and protein (+3%) were expected in response to in-season N fertilization.
- This was based on an SI of 0.86 indicating crop deficiency at the early tillering stage, soil nitrate-N fertilizer equivalent showing very little nitrate available in the top foot of soil (7 lb/ac N), a site with high productivity potential (average yield of 8000 lb/ac and 11% protein), and remaining seasonal N uptake of approximately 181 lb/ac.
- The crop stand was strong, and sufficient irrigation water to incorporate a fertilizer topdress of urea and meet crop water demand was applied following the in-season N application.
- Based on this information, 200 lb/ac N as urea were applied on 5/20/20.
- In addition to the reference zones, two 20ft x 20ft exclusion zones, where no in-season N fertilizer was applied, were created for comparison purposes.
- A 20ft x 20ft tarp was used to cover each of the exclusion zones during the broader field fertilization that occurred in-season.
- NDVI measurements taken on 6/12/20, after the in-season fertilizer had been applied, resulted in an SI of approximately 0.99. This indicated that there was no longer crop N deficiency in the broader field. On the other hand, NDVI measurements in the exclusion zones resulted in a SI of 0.70, indicating increasing crop N deficiency since the assessment on 5/15/20.

OUTCOMES:

- In-season N fertilizer recommended and applied (in-season)
  - 200 lb/ac
- Yield
  - 8,567 lb/ac, 7% above historical average
  - Yield in the exclusion zone, where no in-season N fertilizer was applied, was 57% of the field yield.
- 9.7% of protein, lower than the 11% historical average
- Crop N removal
  - 181.3 lb/ac
- Total N fertilizer applied
  - Pre-season: 0 lb/ac
  - In-season: 200 lb/ac

Figure 2. Exclusion zone (no in-season fertilization) at flowering stage of growth. Picture taken on 7/10/2020.

End of season results:

- The 2020 wheat yield was 8567 lb/ac in this field, which was more than 500 lb/ac greater than the historical average. Grain protein level was 9.7%, which was below average. However, moderate protein levels are desired for soft wheat varieties, and 9.7% is acceptable.
- There was no statistical difference between the yields of the broader field (8567 lb/ac) and the N-rich reference zones (8731 lb/ac), which received 140 lb/ac N pre-plant in addition to the 200 lb/acre N applied in-season. In contrast, the yield in the exclusion zone, where no N fertilizer was applied, was significantly lower (4769 lb/ac).
- The large increase in crop productivity predicted from the in-season assessment of the plant-soil N status on 5/15/20 proved to be accurate.
- In-season N fertilization maintained high yields at this site, where no pre-plant N was applied. The N-rich reference zones provided an opportunity to fine-tune N rates in-season according to real-time assessments of plant and soil N status.
- Relatively high N use efficiency was achieved, with N fertilizer management resulting in a nitrogen use efficiency quotient (N applied / N removed) of 1.1.